GROWTH KINETICS OF ANODIC ALUMINIUM OXIDE FILMS FORMED IN SULPHAMIC ACID

D.KANAGARAJ, V.RAJ, M.P.RAJARAM AND G.BALASUBRAMANIAN
CENTRAL ELECTROCHEMICAL RESEARCH INSTITUTE, KARAIKUDI-630006, INDIA

INTRODUCTION

Kinetics of growth of porous anodic aluminium oxide film and their structures using Sulphuric acid, Oxalic acid, Phosphoric acid electrolytes has been studied extensively [1-5]. But kinetics of growth of oxide film on aluminium using sulphamic acid electrolyte has not yet been studied in detail. In this paper an investigation has been carried out to study the kinetics of growth of oxide film in sulphamic acid by employing the kinetic model suggested by Patermarakis etal (1) for sulphuric acid system. $m=kit-\lambda_1 t \exp(\lambda_2 t)$ where m is the mass of oxide formed, k is the electrochemical equivalent, λ_1 and λ_2 are parameters depending on current density (i) and bath temperature (BT).

EXPERIMENT

Al 1100 aluminium alloy specimen of area $20cm^2$ was anodized in 15% (w/v) sulphamic acid electrolyte at various current densities (1-4A/dm^2) at temperatures (25˚C-35˚C) for various anodizing time after conventional pretreatment .The mass of the oxide film was calculated from the weight of Al before and after stripping, the thickness of oxide film was measured using dermitron thickness meter.

RESULT AND DISCUSSION

The effect of anodizing time on mass and thickness of oxide film at various current densities and temperatures has also been studied in order to derive the various kinetic parameters such as pore volume, pore diameter, mean pore diameter, mass of dissolved oxide film, pore density, porosity, dissolution rate, true current density, activation energy to obtain information about main structural characteristics of oxide films.

It was found that true current density (i_t) increases with decrease in bath temperature (BT) as indicated in column (8) of Table.1. It was also found that number of pores per unit area n as indicated in column (6) of Table.1 is not very sensitive to i variations. The parameters λ_1 and λ_2 as indicated in columns (3) and (4) of Table.1 are directly related to the surface area of pore base section and dissolution rate of pore wall oxide respectively. Oxide dissolution rate was found to be 0.06 to 0.13Å for oxidation temperature of 25-35ºC.The mean diameter of the pore and the pore volume were calculated and are indicated in columns (10) and (11) of Table.1.It was also found that the value of $n^{0.5}$ k_d is directly related to the current density and bath temperature as indicated in column (9) of Table.1.

It has been observed that oxide dissolution is essentially field-assisted process and thermally activated with an activation energy (E_a) of 125.32 kJ/mol. Further results are discussed in the paper.

Table 1:Kinetic Parameters calculated for Al alloy in sulphamic acid for various current densities at different temperatures

BT /°C	I/mA /cm^2	$10^3\lambda_1$g/min	$10^3\lambda_2$/min	Do/Å	10^{-13}n/m^2	nDo^2	I/mA/cm^2	10^4n^0.5*kd	D /Å	10^9v /m^3
25	10	29.54	1	265	9.51	0.06675	95.4	1.29	272	2.69
25	15	46.991	0.07	225	1.40	0.070788	145	0.931	229	3.68
25	20	62.964	0.6	200	1.78	0.071137	179	0.800	203	5.10
30	10	32.129	0.6	270	9.96	0.072599	87.7	0.808	275	3.48
30	15	46.551	0.6	245	1.17	0.070126	136	0.794	249	3.92
30	20	63.317	0.6	220	1.48	0.071536	178	0.802	224	4.57
30	30	91.027	1.2	205	1.63	0.068562	279	1.57	212	5.02
30	40	123.7	1	195	1.84	0.069879	365	1.32	201	6.22
35	10	31.663	0.9	285	8.81	0.071547	89.01	1.20	294	1.16
35	15	47.663	0.9	260	1.06	0.0718	133	1.21	268	2.33
35	20	64.043	0.8	235	1.31	0.072357	176	1.08	242	3.50

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